

What is claimed as new and desired to be protected by Letters Patent of the United States is:

1. A sensing device comprising:

a substrate;

a sensing region at a surface of the substrate that receives incident light, the sensing region absorbing a majority of incident light at wavelengths shorter than an upper wavelength and transmitting a majority of incident light at wavelengths longer than the banding wavelength;

a filter structure over the sensing region that filters incident light before it reaches the sensing region; the filter structure absorbing a majority of incident light at wavelengths shorter than a lower wavelength and transmitting a majority of incident light at wavelengths longer than the lower wavelength; and

readout circuitry at the surface of the substrate that provides readout signals indicating a quantity of incident light absorbed in the sensing region.

2. The sensing device of claim 1, wherein the filter structure comprises a polysilicon filter.

3. The sensing device of claim 1, wherein the filter structure comprises an epitaxial silicon filter.

4. The sensing device of claim 1, wherein the lower wavelength is approximately between blue and green visible light, and the upper wavelength is approximately between green and red visible light.

5. The sensing device of claim 4, wherein the lower wavelength is approximately between green and red visible light, and the upper wavelength is longer than red visible light.

6. The sensing device of claim 1, wherein the filter structure is photolithographically patterned.

7. The sensing device of claim 1, wherein the filter structure blocks non-normally incident light.

8. An integrated circuit comprising:

a substrate;

a pixel array, each of a set of pixels in the pixel array comprising:

a photosensor at or beneath a surface of the substrate; and

a filter comprising polysilicon or epitaxial silicon over said photosensor, the filter absorbing a majority of light at wavelengths shorter than a first wavelength and transmitting a majority of light at wavelengths longer than the first wavelength;

the photosensor receiving light transmitted by the filter, absorbing a majority of light received at wavelengths shorter than a second wavelength and longer than the first wavelength, and transmitting a majority of light received at wavelengths longer than the second wavelength.

9. A sensing device comprising:

a substrate;

a sensing region at a surface of the substrate that receives incident light, the sensing region absorbing a majority of incident light at wavelengths shorter than a bounding wavelength and transmitting a majority of incident light at wavelengths longer than the bounding wavelength; and

readout circuitry at the surface of the substrate that provides readout signals indicating a quantity of incident light absorbed in the sensing region.

10. The sensing device of claim 9, wherein the bounding wavelength is approximately between blue and green visible light.

11. An image pixel array in an imaging device, comprising:

at least one a photosensor at or beneath a surface of a substrate; and

a filter comprising polysilicon or epitaxial silicon layer over said photosensor, the filter absorbing a majority of light at wavelengths shorter than a first wavelength and transmitting a majority of light at wavelengths longer than the first wavelength;

the photosensor receiving light transmitted by the filter, absorbing a majority of light received at wavelengths shorter than a second wavelength and longer than the first wavelength, and transmitting a majority of light received at wavelengths longer than the second wavelength.

12. The image pixel array of claim 11, wherein said at least one photosensor is formed beneath an upper surface of said substrate.

13. The image pixel array of claim 12, wherein said photosensor is selected from the group consisting of a photo diode, photogate, photoconductor, or other image to charge converting device for initial accumulation of photo-generated charge.

14. The image pixel array of claim 11, wherein said polysilicon or epitaxial silicon layer is formed to attenuate only light having a wavelength of blue light.

15. The image pixel array of claim 11, wherein said polysilicon or epitaxial silicon layer is formed to attenuate light having a wavelength of blue light and light having a wavelength of green light.

16. The image pixel array of claim 11, wherein a layer of tetracthyl orthosilicate is formed over said polysilicon or epitaxial silicon layer.

17. The image pixel array of claim 11, wherein a second layer of polysilicon is formed over said polysilicon or epitaxial silicon layer.

18. The image pixel array of claim 11, wherein an insulating layer is formed over said polysilicon or epitaxial silicon layer.

19. The image pixel array of claim 18, wherein electrical contacts are formed in said insulating layer.

20. The image pixel array of claim 11, wherein said pixel array is formed of about 1.3 megapixels to about 4 megapixels.

21. The image pixel array of claim 11, wherein the filter blocks non-normally incident light.

22. An image pixel array in an imaging device, comprising:

a plurality of photosensors at a surface of a substrate, said plurality comprising a first set, second set and third set of photosensors;

a first polysilicon filter over each of said first set of photosensors, said first polysilicon filter comprising part of a first patterned layer of polysilicon over the photosensor;

a second polysilicon filter over each of said second set of photosensors, said second polysilicon filter comprising part of the first patterned layer over the photosensor and part of a second patterned layer of polysilicon over said first patterned layer; and

readout circuitry at the substrate's surface that provides readout signals indicating a quantity of incident light absorbed in the photosensors;

each first polysilicon filter absorbing a majority of light at wavelengths shorter than a first wavelength and transmitting a majority of light at wavelengths longer than the first wavelength;

each of the first set of photosensors receiving light transmitted by the first polysilicon filter, absorbing a majority of light received at wavelengths shorter than a second wavelength and longer than the first wavelength, and transmitting a majority of light received at wavelengths longer than the second wavelength;

each second polysilicon filter absorbing a majority of light at wavelengths shorter than a third wavelength approximately equal to the second wavelength and transmitting a majority of light at wavelengths longer than the third wavelength;

each of the second set of photosensors receiving light transmitted by the second polysilicon filter, absorbing a majority of light received at wavelengths shorter than a fourth wavelength and longer than the third wavelength, and transmitting a majority of light received at wavelengths longer than the fourth wavelength; and

each of the third set of photosensors absorbing a majority of light received at wavelengths shorter than a fifth wavelength approximately equal to the first wavelength, and transmitting a majority of light received at wavelengths longer than the fifth wavelength.

23. An image pixel array in an imaging device, comprising:

a plurality of photosensors at a surface of a substrate, said plurality comprising a first set, second set and third set of photosensors;

a first epitaxial silicon filter over each of said first set of photosensors, said first epitaxial silicon filter comprising part of a first patterned layer of epitaxial silicon over the photosensor;

a second epitaxial silicon filter over each of said second set of photosensors, said second epitaxial silicon filter comprising part of the first patterned layer over the photosensor and part of a second patterned layer of epitaxial silicon over said first patterned layer; and

readout circuitry at the substrate's surface that provides readout signals indicating a quantity of incident light absorbed in the photosensors;

each first epitaxial silicon filter absorbing a majority of light at wavelengths shorter than a first wavelength and transmitting a majority of light at wavelengths longer than the first wavelength;

each of the first set of photosensors receiving light transmitted by the first epitaxial silicon filter, absorbing a majority of light received at wavelengths shorter than a second wavelength and longer than the first wavelength, and transmitting a majority of light received at wavelengths longer than the second wavelength;

each second epitaxial silicon filter absorbing a majority of light at wavelengths shorter than a third wavelength approximately equal to the second wavelength and transmitting a majority of light at wavelengths longer than the third wavelength;

each of the second set of photosensors receiving light transmitted by the second epitaxial silicon filter, absorbing a majority of light received at wavelengths shorter than a fourth wavelength and longer than the third wavelength, and transmitting a majority of light received at wavelengths longer than the fourth wavelength; and

each of the third set of photosensors absorbing a majority of light received at wavelengths shorter than a fifth wavelength approximately equal to the first wavelength, and transmitting a majority of light received at wavelengths longer than the fifth wavelength.

24. An imager system, comprising:

a processor; and

an imaging device coupled to said processor, said imaging device comprising:

a semiconductor substrate; and

a pixel array, said pixel array comprising:

at least one photosensor at or beneath a surface of a substrate; and

a polysilicon filter over said photosensor, the polysilicon filter absorbing a majority of light at wavelengths shorter than a first wavelength and transmitting a majority of light at wavelengths longer than the first wavelength;

the photosensor receiving light transmitted by the polysilicon filter, absorbing a majority of light received at wavelengths shorter than a second wavelength and longer than the first wavelength, and transmitting a majority of light received at wavelengths longer than the second wavelength.

25. An imager system, comprising:

a processor; and

an imaging device coupled to said processor, said imaging device comprising:

a semiconductor substrate; and

a pixel array, said pixel array comprising:

at least one photosensor at or beneath a surface of a substrate; and

an epitaxial silicon filter over said photosensor, the epitaxial silicon filter absorbing a majority of light at wavelengths shorter than a first wavelength and transmitting a majority of light at wavelengths longer than the first wavelength;

the photosensor receiving light transmitted by the epitaxial silicon filter, absorbing a majority of light received at wavelengths shorter than a second wavelength and longer than the first wavelength, and transmitting a majority of light received at wavelengths longer than the second wavelength.

26. An integrated circuit comprising:

a substrate;

a pixel array, each of a set of pixels in the pixel array comprising:

a photosensor at or beneath a surface of the substrate; and

a crystal silicon filter over said photosensor, the crystal silicon filter absorbing a majority of light at wavelengths shorter than a first wavelength and transmitting a majority of light at wavelengths longer than the first wavelength;

the photosensor receiving light transmitted by the crystal silicon filter, absorbing a majority of light received at wavelengths shorter than a second wavelength and longer than the first wavelength, and transmitting a majority of light received at wavelengths longer than the second wavelength.

27. An image pixel array in an imaging device, comprising:

at least one a photosensor at or beneath a surface of a substrate; and

a crystal silicon filter over said photosensor, the crystal silicon filter absorbing a majority of light at wavelengths shorter than a first wavelength and transmitting a majority of light at wavelengths longer than the first wavelength;

the photosensor receiving light transmitted by the crystal silicon filter, absorbing a majority of light received at wavelengths shorter than a second wavelength and longer than the first wavelength, and transmitting a majority of light received at wavelengths longer than the second wavelength.

28. An image pixel array in an imaging device, comprising:

a plurality of photosensors at a surface of a substrate, said plurality comprising a first set, second set and third set of photosensors;

a first crystal silicon filter over each of said first set of photosensors, said first crystal silicon filter comprising part of a first patterned layer of epitaxial crystal silicon over the photosensor;

a second crystal silicon filter over each of said second set of photosensors, said second crystal silicon filter comprising part of the first patterned layer over the photosensor and part of a second patterned layer of epitaxial crystal silicon over said first patterned layer; and



readout circuitry at the substrate's surface that provides readout signals indicating a quantity of incident light absorbed in the photosensors;

each first crystal silicon filter absorbing a majority of light at wavelengths shorter than a first wavelength and transmitting a majority of light at wavelengths longer than the first wavelength;

each of the first set of photosensors receiving light transmitted by the first crystal silicon filter, absorbing a majority of light received at wavelengths shorter than a second wavelength and longer than the first wavelength, and transmitting a majority of light received at wavelengths longer than the second wavelength;

each second crystal silicon filter absorbing a majority of light at wavelengths shorter than a third wavelength approximately equal to the second wavelength and transmitting a majority of light at wavelengths longer than the third wavelength;

each of the second set of photosensors receiving light transmitted by the second crystal silicon filter, absorbing a majority of light received at wavelengths shorter than a fourth wavelength and longer than the third wavelength, and transmitting a majority of light received at wavelengths longer than the fourth wavelength; and

each of the third set of photosensors absorbing a majority of light received at wavelengths shorter than a fifth wavelength approximately equal to the first wavelength, and transmitting a majority of light received at wavelengths longer than the fifth wavelength.

29. An imager system, comprising:

a processor; and

an imaging device coupled to said processor, said imaging device comprising:

a semiconductor substrate; and

a pixel array, said pixel array comprising:

at least one photosensor at or beneath a surface of a substrate; and

a crystal silicon filter over said photosensor, the crystal silicon filter absorbing a majority of light at wavelengths shorter than a first wavelength and transmitting a majority of light at wavelengths longer than the first wavelength;

the photosensor receiving light transmitted by the crystal silicon filter, absorbing a majority of light received at wavelengths shorter than a second wavelength and longer than the first wavelength, and transmitting a majority of light received at wavelengths longer than the second wavelength.

30. An imager integrated circuit, comprising:

a substrate;

a pixel array at the substrate's surface, the pixel array comprising:

first and second sets of pixels, each including a photosensor;

a first polysilicon filter over each of said first set of photosensors, said first polysilicon filter absorbing a majority of light at wavelengths shorter than a first wavelength and transmitting a majority of light at wavelengths longer than the first wavelength;

a second polysilicon filter over each of said second set of photosensors, said second polysilicon filter absorbing a majority of light at wavelengths shorter than a second wavelength longer than the first wavelength and transmitting a majority of light at wavelengths longer than the second wavelength; and

readout circuitry at the substrate's surface that provides readout signals indicating a quantity of incident light absorbed in each of the photosensors.

31. An imager integrated circuit, comprising:

a substrate;

a pixel array at the substrate's surface, the pixel array comprising:

first and second sets of pixels, each including a photosensor;

a first crystal silicon filter over each of said first set of photosensors, said first crystal silicon filter absorbing a majority of light at wavelengths shorter than a first wavelength and transmitting a majority of light at wavelengths longer than the first wavelength;

a second crystal silicon filter over each of said second set of photosensors, said second crystal silicon filter absorbing a majority of light at wavelengths shorter than a second wavelength longer than the first wavelength and transmitting a majority of light at wavelengths longer than the second wavelength; and

readout circuitry at the substrate's surface that provides readout signals indicating a quantity of incident light absorbed in each of the photosensors.

32. A method of forming a sensing device that senses light in a wavelength range, comprising:

forming a photosensor at or beneath a surface of a substrate; and

providing a filter formed of polysilicon or epitaxial silicon over said photosensor, the filter absorbing a majority of light at wavelengths shorter than a first wavelength and transmitting a majority of light at wavelengths longer than the first wavelength;

the photosensor receiving light transmitted by the filter, absorbing a majority of light received at wavelengths shorter than a second wavelength and longer than the first wavelength, and transmitting a majority of light received at wavelengths longer than the second wavelength.

33. The method of claim 32, wherein said photosensor is formed beneath the surface of said substrate.

34. The method of claim 32, wherein said photosensor is selected from the group consisting of a photodiode, photogate, photoconductor, or other image to charge converting device.

35. The method of claim 32, wherein the first wavelength is approximately between blue and green visible light.

36. The method of claim 32, wherein the first wavelength is approximately between green and red visible light.

37. The method of claim 32, wherein the second wavelength is approximately between green and red visible light.

38. The method of claim 32, wherein the second wavelength is longer than red visible light.

39. The method of claim 32, further comprising forming a layer of insulating material over said filter.

40. The method of claim 32, wherein the act of forming the filter comprises:

depositing a first layer of polysilicon or epitaxial silicon over the photosensor; and

patterning the first layer of polysilicon or epitaxial silicon.

41. The method of claim 32, wherein the act of forming the filter comprises:

forming a first patterned layer of polysilicon or epitaxial silicon that includes a first portion over the photosensor; and

forming a second patterned layer of polysilicon or epitaxial silicon that includes a second portion on the first portion.

42. The method of claim 32, wherein said filter is a polysilicon filter.

43. The method of claim 42, wherein said polysilicon filter is formed at a thickness of about 193 nm.

44. The method of claim 42, wherein said polysilicon filter is formed at a thickness of about 1034 nm.

45. The method of claim 32, wherein said filter is an epitaxial silicon filter.

46. The method of claim 45, wherein said epitaxial silicon filter is formed at a thickness of about 300 nm.

47. The method of claim 45, wherein said epitaxial silicon filter is formed at a thickness of about 1500 nm.

48. The method of claim 32, wherein said filter is formed to a thickness suitable for blocking non-normally incident light.

49. A method of sensing light in a range between lower and upper wavelengths comprising:

passing light through a filter structure that absorbs a majority of light at wavelengths shorter than the lower wavelength and transmits a majority of light at wavelengths longer than the lower wavelength; and

sensing light transmitted by the filter structure in a sensing structure, the sensing structure including a sensing region that absorbs a majority of light at wavelengths shorter than the upper wavelength, wherein the sensing structure provides an output signal in response to light absorbed in the sensing region.

50. The method of claim 49, wherein the sensing structure is a substrate, the sensing region being at a surface of the substrate, the filter structure being photolithographically patterned on the substrate's surface.

51. The method of claim 49, wherein the sensing structure provides an output signal in response to light absorbed in the sensing region.

52. The method of claim 49, wherein the filter structure is a layered polysilicon structure with at least one layer.

53. The method of claim 49, wherein the filter structure is a layered epitaxial silicon structure with at least one layer.

54. A method of forming an array of sensing devices each of which senses light, comprising:

forming a plurality of photosensors and polysilicon filter elements at a surface of a substrate, said plurality comprising a first set and second set of photosensors, each of said first and second sets of photosensors having respective polysilicon filter elements;

the act of forming the photosensors and polysilicon filters comprising:

forming a first patterned layer of polysilicon, the first patterned layer including a respective part over each of said first set and said second set of photosensors; and

forming a second patterned layer of polysilicon, the second patterned layer including a respective part over the part of the first patterned layer over each of said second set of said photosensors;

the part of the first patterned polysilicon layer over each of the first set of photosensors being a filter that absorbs a majority of light at wavelengths shorter than a first wavelength and transmits to the photosensor a majority of light at wavelengths longer than the first wavelength;

the parts of the first and second patterned polysilicon layers over each of the second set of photosensors being a filter that absorbs a majority of light at wavelengths shorter than a second wavelength longer than the first wavelength and transmits to the photosensor a majority of light at wavelengths longer than the second wavelength.

55. A method of forming an array of sensing devices each of which senses light, comprising:

forming a plurality of photosensors and epitaxial silicon filter elements at a surface of a substrate, said plurality comprising a first set and second set of photosensors, each of said first and second sets of photosensors having respective polysilicon filter elements;

the act of forming the photosensors and epitaxial silicon filters comprising:

forming a first patterned layer of epitaxial silicon, the first patterned layer including a respective part over each of said first set and said second set of photosensors; and

forming a second patterned layer of epitaxial silicon, the second patterned layer including a respective part over the part of the first patterned layer over each of said second set of said photosensors;

the part of the first patterned epitaxial silicon layer over each of the first set of photosensors being a filter that absorbs a majority of light at wavelengths shorter than a first wavelength and transmits to the photosensor a majority of light at wavelengths longer than the first wavelength;

the parts of the first and second patterned epitaxial silicon layers over each of the second set of photosensors being a filter that absorbs a majority of light at wavelengths shorter than a second wavelength longer than the first wavelength and transmits to the photosensor a majority of light at wavelengths longer than the second wavelength.

56. A method of forming a sensing device that senses light in a wavelength range, comprising:

forming a photosensor at or beneath a surface of a substrate; and

forming a crystal silicon filter over said photosensor, the crystal silicon filter absorbing a majority of light at wavelengths shorter than a first wavelength and transmitting a majority of light at wavelengths longer than the first wavelength;

the photosensor receiving light transmitted by the crystal silicon filter, absorbing a majority of light received at wavelengths shorter than a second wavelength and longer than the first wavelength, and transmitting a majority of light received at wavelengths longer than the second wavelength.

57. A method of forming an array of sensing devices each of which senses light, comprising:

forming a plurality of photosensors and crystal silicon filter elements at a surface of a substrate, said plurality comprising a first set and second set of photosensors, each of said first and second sets of photosensors having respective crystal silicon filter elements;

the act of forming the photosensors and crystal silicon filters comprising:

forming a first patterned layer of epitaxial crystal silicon, the first patterned layer including a respective part over each of said first set and said second set of photosensors; and

forming a second patterned layer of epitaxial crystal silicon, the second patterned layer including a respective part over the part of the first patterned layer over each of said second set of said photosensors;

the part of the first patterned epitaxial crystal silicon layer over each of the first set of photosensors being a filter that absorbs a majority of light at wavelengths shorter than a first wavelength and transmits to the photosensor a majority of light at wavelengths longer than the first wavelength;

the parts of the first and second patterned epitaxial crystal silicon layers over each of the second set of photosensors being a filter that absorbs a majority of light at wavelengths shorter than a second wavelength longer than the first wavelength and transmits to the photosensor a majority of light at wavelengths longer than the second wavelength.